IV.—*On the Colours of Leaves and Petals.* By William E. C. Nourse, M.R.C.S.

The colours of leaves and petals depend on several conditions; some mechanical or structural, and some chemical. The latter have been made the subject of many investigations. The former, though requiring little more than common observation, have been passed over, or but slightly noticed. It is to a clearer knowledge of these that the present paper, so far as it goes, is intended to contribute.

The structural or mechanical circumstances which influence the colours are, 1st, the situation of the coloured cells; 2nd, their size, form and number; 3rd, their mixture with each other; and 4th, their degree of visibility.

1. The situation of the coloured cells is different in leaves and petals, though their general structure is anatomically similar. If a leaf be torn, the green colour appears to be in the central substance; while in a petal the centre is nearly white, and the colour peels off with the cuticle. This difference merits a degree of attention which has not hitherto been paid to it.

The structural parts of a leaf or petal are, the *substance*, consisting of cellular tissue and venous ramifications; the *cuticle*, or epidermis; and a layer of cells immediately beneath the cuticle, to which we may give the provisional name of *Rete*.

This latter structure is seldom mechanically distinct, but is either continuous with the substance, as in leaves, or adherent to the cuticle, as in petals; though it can sometimes be shown in a separate form in petals of a large size. Its characters, however, effectually distinguish it from the other structures. It is the densest parenchyma of the organ, consisting of an immense number of nearly circular cells without any interstices. But the circumstance which makes it most conspicuous is, that it is the seat of colouring matters which are scarcely found in the other structures. The rete thus appears entitled to be considered as a distinct tissue, and may be found to perform important functions, especially in the petals, in which its development is most distinct.

The colours of the rete possess an almost endless variety, and, in fact, it is in this structure that the most highly coloured cells are always found. Of petals, it contains the entire colouring; the yellow, red, blue, brown, black, and all the intermediate tints are wholly produced in its cells, and can be completely removed by simply stripping it off with the cuticle. This can be easily done with any common flower. In leaves the rete is the seat of all the modifications of the green colour which those organs present, excepting variegation, cuticular changes, and what may be called

venous colours, like red cabbage, &c. All dark shades of green are the effect of an immense crowding together of green cells in the rete, as may be readily seen in the yew, the bay, the holly, &c.; and all those lesser variations and shades, such as brownish and reddish, and a number of others, which add so much to the beauty of each leaf and to the picturesque effect of the whole, are due (with the above exceptions) to the different colours of the cells in the rete. Of this kind are the shadings in the leaf of the common wild ivy; the reddish tips and edges of rose- and peony-leaves, the purple of the cornel and cineraria, and many similar appearances.

The colours of the substance, on the contrary, are marked by their want of intensity and by their extreme simplicity. Few coloured cells are found in this structure. In petals it is either white or lightish, or some faint shade of the general colour of the flower. It requires some care to show this in small specimens; but in large ones, such as garden poppies or peonies, the cuticle and rete can be easily peeled off on both sides, and the colourless substance shown in a distinct form, having the exact shape of the petal.

The substance in leaves is always green, except in the light parts of variegated leaves, or in leaves of unusual thickness, like the aloe. With these exceptions, there is but little difference in the shade of green between the substance of one leaf and that of another, taking them, of course, in a state of health and maturity. Thus, in the holly and ivy, the substance is very little darker than it is in the beech or laurel. In a great number of leaves the difference of shade is not perceptible; and even in the holm-oak, remarkable for its gloomy foliage, the green of the substance is not by any means so dark as might be imagined.

It will thus be seen that the coloured cells both in leaves and petals are chiefly placed in the rete. A few are occasionally found in the substance of petals, and a certain number in that of leaves; but not in general sufficient to determine the outward colour.

2. The size, form and number of the coloured cells always vary with the intensity of the general colour of the structure. When the colour is very deep the cells are small, roundish, and densely packed together in immense numbers. This is their appearance in the rete. If the colour is lighter the cells are larger, more elongated, and less closely packed together, as they are seen in the substance of leaves, and of those petals which are somewhat coloured throughout; and where there is little or no colour, as in the substance of the greater number of petals, the cells are generally large and oblong, often muriform, and with distinct intercellular passages.

In white flowers, the cells which contain opake white matter are always rounder and more thickly packed together than the empty cells.

3. Tints may be produced by the mere mechanical mixture of the coloured cells. In these cases no union of the colours takes place, but they remain distinct in their separate cells, side by side. When the cells are mixed with regularity, a uniform tint results; but when the colours are more or less massed together, variegation or marking is the consequence. Coloured cells sometimes lie over one another, causing a new tint by one layer being seen through the other.

The leaf of the *Pelargonium zonale* is well-known for its peculiar dark stain. This is entirely in the rete, for the substance of the leaf is pure green. The rete however, viewed carefully in various sections beneath the microscope, appears to consist, not of dark cells, but of distinct red and green ones, very minute, densely packed together and intermingled; and it is by this juxtaposition of the red and green, and by the green cells of the substance being partially visible through it, that the effect of a dark tint seems to be caused. The leaf of the variegated elder presents an appearance of similar origin. Some parts of the leaf are of a decided green, and some almost white; but there are also patches of a sort of imperfect green, paler, and somewhat glaucous. The substance in these parts is not less green than in the darkest parts of the leaf, as may be seen by looking at the under surface; but the rete, instead of containing dark green cells, consists of a thin layer of white ones; and these, with the cuticle, to which they are adherent, by lying over the green substance, produce the glaucous appearance.

4. The cuticle in this instance contributes to the effect. This structure has not yet been mentioned, because coloured cells are never found in it; and it merely modifies the appearances of colours by regulating the visibility of the coloured cells. This is so obvious, that it only needs to be referred to, as well as the effects of the cuticular appendages.

In most petals the cuticle is extremely delicate; often consisting of the finest web, impossible to be detached, and only to be seen occasionally at the carefully torn edges of a flower. It is somewhat thicker in large petals, and can then be raised and torn off in shreds. Of course, in these instances, it is perfectly transparent, and permits the colours to be seen through it in the most distinct manner.

Such are the structural circumstances relating to the colours of leaves and petals. Simple as they are, and easily observed, they required to be stated, to receive their proper share of attention. The chief points about them are, the anatomical differences

between leaves and petals in the situation of the colours; and the location of the colours of the petals in the rete, a fact hitherto unnoticed, and one which may hereafter throw light on some interesting points of vegetable physiology.

Reference was made to another kind of colours, also found in the leaves and petals. These, with their peculiarities, which may prove not devoid of practical interest, together with some other matters connected with the subject or suggested by it, remain to be brought forward at some future time.

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V.—*Descriptions of Coleopterous Insects collected by* Charles Darwin, Esq., *in the Galapagos Islands.* By George R. Waterhouse, Esq.

The insects here described are nearly all of small size, and none of them display any brilliant colouring. Some of the species are referable to a little group found in Chile and Peru,—the genus *Ammophorus*, a genus hitherto only found in those parts; others appertain to a genus (*Anchonus*) which is almost confined to the West Indian islands and the northern parts of South America. Again, in the collection under consideration are species of genera which are found all over the world or nearly so, such as *Feronia*, *Notaphus* and *Oryctes**; and, lastly, there are species

* It is from genera like these, which have a very wide geographical range, that the minor, local groups appear as it were to radiate. Those genera which are confined to comparatively limited districts, often containing but few species, and also often presenting very remarkable abnormal modifications of structure, are in most cases referable to some family which has representatives in most parts of the world. Groups of high value, such as classes, are never confined to any particular quarter of the globe; and even when we descend to families, restricted as they now are by naturalists, it is comparatively rare to find them so defined as not to embrace species from widely separated localities. Genera may be arranged under three principal categories as regards their geographical distribution. First may be noticed those of universal range, such as *Cicindela*; secondly, those which occur in both hemispheres but affect particular zones, such as *Megacephala*, which is confined to the tropical zone; and thirdly, those which are restricted to a comparatively small district, such as *Manticora*, which is confined to South Africa. These genera all belong to the same family of beetles, and of this family *Manticora* presents certainly one of the most aberrant forms. The genus *Cicindela* would by most entomologists be regarded as the typical genus of the family *Cicindelidæ*, and here we find, as in many other cases, the presumed typical genus has a universal range; it may be inquired, therefore, whether such is not generally the case.

I must here observe that Mr. Swainson has expressed the opinion that typical genera have a great geographical range; I was not aware, however, of this fact until after the idea had been suggested to me by a tabular arrangement which I had formed of the Mammalian order Rodentia, in which